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# Where Have All the Weed Science Gone? And Other Little Things That Influence Weed Populations

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## WHERE HAVE ALL THE WEED SEEDS GONE? AND OTHER LITTLE THINGS THAT INFLUENCE WEED POPULATIONS

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### Introduction

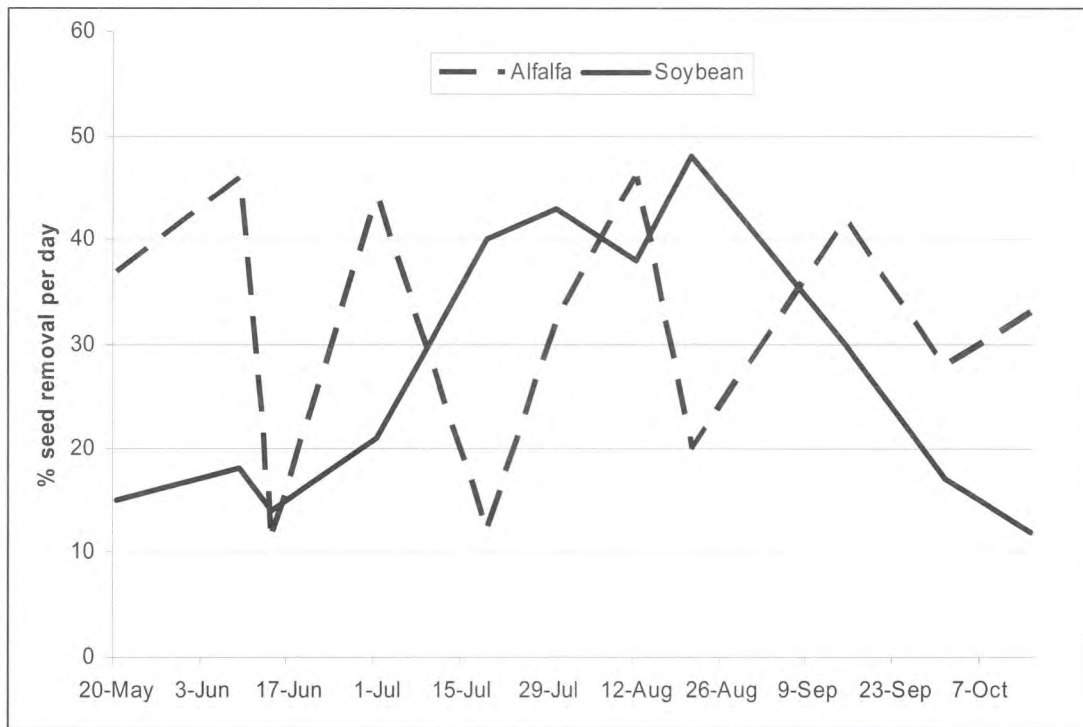
In the current era of herbicide-based weed management systems, it is easy to assume the success of weed management is based solely on appropriate selection and application of herbicides. However, many factors place selection pressures on weeds, and these subtle influences may determine the long-term success or failure of a weed control program. As farmers manage more acres with less equipment and manpower, it will become increasingly important to take advantage of any and all available tactics that can help maintain the effectiveness of modern herbicides. This paper will provide a brief overview of some of the less obvious factors that regulate weed communities in agronomic fields.

### Seed Predation

A common characteristic of most weeds is the ability to produce large quantities of seed. Abundant seed production is critical for survival in habitats with frequent high mortality events (tillage, herbicide application, etc.). Waterhemp exemplifies this trait, with a single plant capable of producing several million seeds under ideal conditions, and still being able to produce several hundred thousand seed when competing with soybean. Simple calculations based on seed production capacity and seed germination rates suggest that the soil surface in a no-till field should be covered by a layer of waterhemp seed several seed thick after a few years of poor weed control. However, experience tells us that although weed seed banks can build up to high densities ( $>100,000$  seed per  $m^2$ ), they never reach the level where we are literally walking on seeds. Obviously something is happening in agricultural fields that limits the accumulation of weed seeds.

Recent research documents that a variety of organisms resides in or near fields and rely on weed seed as an important food source. The seed predators most frequently found in agronomic fields include ground beetles, field crickets and a variety of vertebrates (field mice, birds, etc.). In studies where weed seed are placed on the soil surface a high percentage of these seeds are consumed by the predators. Averaged over several sampling dates during the growing season, 18% and 22% of velvetleaf and giant foxtail seed, respectively were removed per day by predators. Most predators prefer small weed seed (pigweed, lambsquarter, foxtail) compared to larger seeds (velvetleaf, giant ragweed, morningglory). Although predators are active throughout the growing season, activity is greatest when a plant canopy covers the soil surface. In alfalfa predation rates fluctuated widely in response to cutting (Figure 1). For example, seed removal averaged less than 20% per day soon after cutting (June 16, July 17 and August 15), whereas removal exceeded 40% per day when a full alfalfa canopy was present (June 6, July 1, August 12). In soybean predation rates increased throughout the growing season as the crop canopy developed, and then declined rapidly with crop senescence and harvest.

Figure 1. Effect of sampling date on seed predation rates in alfalfa and soybean. Liebman et al. 2003.



Researchers in Michigan reported that invertebrate seed predators were much more abundant in no-till soybean fields than in conventional till fields or fields maintained in organic production (Table 1). Removal of fall panicum seeds by predators during the growing season was closely correlated with predator numbers. Fencerows, grass waterways and other habitats that provide permanent vegetative cover serve as over wintering and refuges for seed predators and may enhance predation rates in fields.

Table 1. Influence of production system on numbers of seed predators and fall panicum seed removal in Michigan soybean fields. Menalled et al. 2000.

Production system	Total number of seed predators	Avg. number of fall panicum seeds removed per week
Conventional till	32	5
No-till	121	12
Organic	28	6

The high level of weed seed predation observed in research trials suggests that seed predators could influence weed communities in agronomic fields. Yet to be determined is the relative importance of seed predation compared to other production practices that influence weed population dynamics. In addition, it has not been determined whether the benefit of increased seed predation is great enough to warrant modifying production practices to enhance the activity



of seed predators. However, current research may provide answers to these questions and provide new methods of approaching weed management.

### Cultural Practices

Students in introductory weed science courses are taught that efficient weed management programs rely on a combination of cultural, mechanical and chemical tactics. Cultural weed control can be defined as the manipulation of the cropping system to reduce the density and competitiveness of weeds. Narrow-row spacing and delayed planting are cultural practices used in row-crop production to improve weed management. Prior to the development of modern herbicides, the need to control weeds influenced nearly every aspect of crop production. However, today's highly effective herbicides have allowed the separation of weed control from other crop management practices. However, it is important to realize that even in systems relying on herbicides such as glyphosate that small things can still make a big difference in the overall effectiveness of a weed control program.

A recent paper in *Weed Technology* out of Nebraska illustrates how cultural practices can influence weed management systems based on herbicides (Wicks et al. 2003). The paper reported results of a survey in which weed populations in wheat stubble were determined in 179 fields three to five weeks after herbicide application in an eco-fallow system. Relationships between weed populations and various management practices used during wheat production were determined.

Several management practices were found to influence weed populations, some that would be expected and others that are somewhat surprising. Herbicides were more effective in fields with high wheat stem densities. Fields in which herbicide activity was rated excellent averaged 59 wheat stems per ft<sup>2</sup>, whereas in fields where herbicide activity was rated fair or poor averaged only 45 stems per ft<sup>2</sup>. Selection of crop cultivars with enhanced competitiveness with weeds is frequently cited as a method of reducing dependence on herbicides, yet is a trait not normally selected for in breeding programs. In wheat, stem height is the trait most closely associated with competitiveness. Taller wheat varieties usually suppress weeds more effectively than short varieties due to increased shading. Smartweed and toothed spurge populations were higher in fields planted with short varieties than tall; however, lambsquarter populations were greater with tall varieties. The reason for the greater prevalence of lambsquarter in fields with tall varieties is that fewer of these fields were treated with herbicides in the spring to control weeds. Thus, while the taller varieties did not totally smother lambsquarter, the enhanced competitiveness did reduce the need for postemergence herbicide applications.

Table 2. Effect of wheat stem height on post harvest weed densities. Wicks et al. 2003.

	PA Smartweed	Toothed Spurge	Lambsquarter spp.
	-----Number per m <sup>2</sup> -----		
Tall	0.0 b	0.001 b	2.24 a
Medium	0.0 b	0.010 b	0.01 b
Short	1.5 a	0.390 a	0.01 b

Among the other factors found to influence weed densities were row direction and type of drill used to plant wheat. Fields in which the wheat was planted in an east-west direction had 98% more stinkgrass and 98% more tumble pigweed than fields planted in a north-south direction. Row direction influences how much sunlight penetrates the crop canopy and is available to support weed development. Fields planted with disk drills typically had greater weed infestations than hoe drills, presumably due to effects the drill had on placement of weed seed in the furrow. Hoe drills favor establishment of weed within the wheat row where there is a greater likelihood of the weed getting smothered by the crop.

The Nebraska survey illustrates that production practices normally not viewed as significantly impacting weeds can influence herbicide performance. So what can be done in the corn-soybean rotation practiced in the northern Cornbelt? Providing the crop with a slight advantage over the weed can provide long-term benefits in weed management. For example, each day waterhemp emergence is delayed in relation to the crop during the first ten days after crop emergence results in a 6 to 8% decrease in seed production. Thus, small increases in crop growth early in the season enhance the crop's competitiveness with weeds. A weed population model developed by Matt Liebman demonstrates the benefit of a suppressive crop in terms of long-term weed management. According to the model, velvetleaf seed bank densities in a corn-soybean rotation would approximately double over a 15 year period with a herbicide-based management system providing 99.5% control. However, reducing the fecundity of velvetleaf by 20% allowed the management program to maintain the seed bank near the initial level over the 15 year period. The important point is that a farmer, crop consultant or weed scientist most likely would not notice a 20% reduction in weed fecundity caused by a more competitive crop. But if the reduction in weed fecundity can be sustained for several years the impact on the soil seed bank would pay big dividends in maintaining effective weed control.

### Summary

The high level of effectiveness of modern herbicides tends to diminish our view of the importance of any control tactic that won't provide 90% control or better. However, subtle reductions in weed competitiveness through cultural practices can enhance the effectiveness of weed management programs and influence long-term weed population dynamics. In order to preserve the effectiveness of herbicides it will become increasingly important to take advantage of any additional tactics that suppress weed populations.

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